Waves and Fetch in the Marginal Ice Zone

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LONG-TERM GOALS

The long-term goal is to improve prediction of the arctic Marginal Ice Zone (MIZ) by improving basic understanding of the interaction between waves, sea ice, and open water (i.e., fetch).

OBJECTIVES

The primary objective is to improve wave source/sink parameterizations by directly measuring the growth and dissipation of waves in the MIZ. The secondary objective is to develop a surface wave climatology of the arctic ocean and the relation to the seasonal MIZ.

APPROACH

The technical approach is to use custom Surface Wave Instrument Floats with Tracking (SWIFT) to measure waves, winds, and turbulence at the air-sea-ice interface. Figure 1 shows the SWIFT with an example observation of a breaking wave and related turbulent energy dissipation rate. These seasonal SWIFT measurements are to be placed in context using mutliyear subsurface Acoustic Wave And Current (AWAC) moorings and regional Wave Watch III model results.

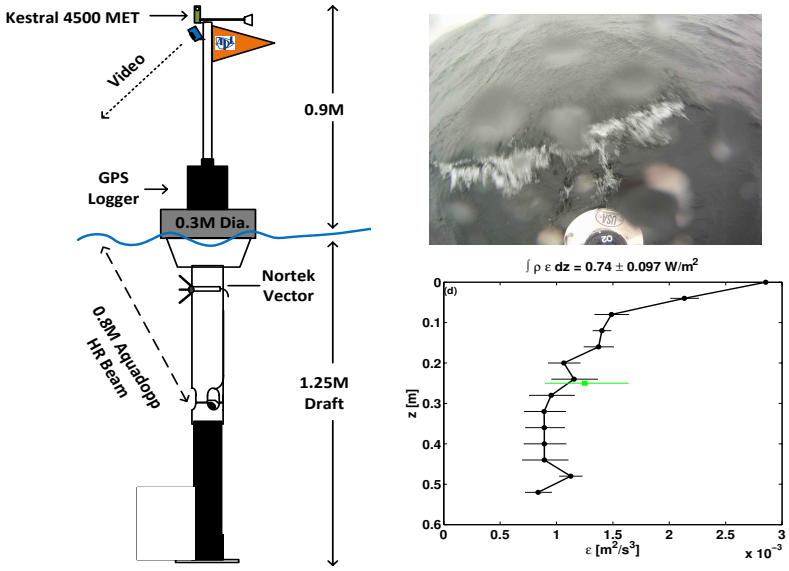

Figure 1: Left: Surface Wave Instrument Float with Tracking (SWIFT). Right: breaking wave example surface image and turbulent dissipation rate. The dissipation rate is shown as a vertical profile from the surface (z=0) downwards beneath the wave.

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WORK COMPLETED

Planning has begun for a large field experiment in 2014. Two planning meetings occurred, with combined logistics and science considerations underway. Mulitple pilot efforts are also underway. Specifically, an AWAC was added to mooring 'A' (75 N, 152 W) of the NSF-funded Beaufort Gyre Exploration Project (BGEP), which was deployed in Aug 2012. The mooring will be serviced in Aug 2013 and will provide the first year-long time series of waves in the Beaufort Gyre. Figure 2 shows the AWAC sub-surface float, designed and built by the WHOI mooring group.

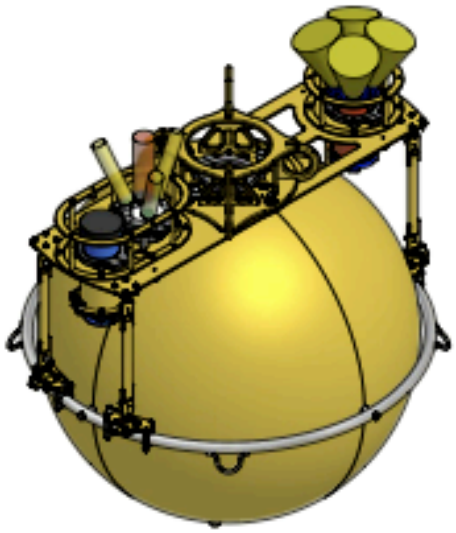

Figure 2: Sub-surface float at BGEP mooring 'A', including the APL-UW Acoustic Wave and Current (AWAC) instrument on the left side. The orange acoustic beam measures wave height and ice draft.

In addition, Wave Watch 3 model hindcasts have been analyzed to estimate the wave climatology of the Beaufort Sea during open water periods and the likely conditions for the 2014 field experiment.

RESULTS

Wave watch 3 hindcast analysis indicates that significant wave heights in the lower Beaufort Sea can reach 5 m soon after the ice retreats from the shore (typically by July 1st, see Figure 3). In August and September, the hindcast wave heights are directly linked to the open water fetch and the storm energy available for wave generation. For the experiment in 2014, the model suggests that assetts deployed in advance on the ice will experience strong wave forcing sequentially south to north, consistent with the assumptions used for the draft MIZ science/experiment plan.

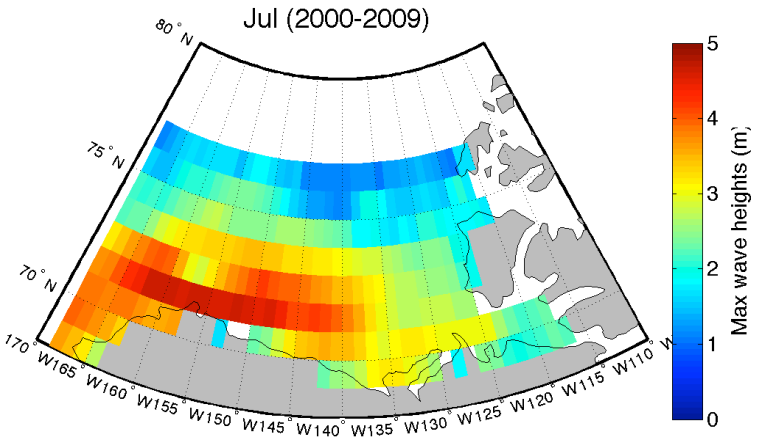

Figure 3: Maximum wave height predicted in the Beaufort Sea during the month of July using Wave Watch 3 hindcasts from 2000 to 2009.

IMPACT/APPLICATIONS

Improved wave and MIZ predictions in the Arctic Ocean will enable safe naval operations in the region.

RELATED PROJECTS

Development of the SWIFT platform and algorithms has been supported via an ongoing NSF project, entitled “Spectral Dissipation of Broad-banded Waves”.

REFERENCES

Thomson, J. “Wave breaking dissipation observed with SWIFT drifters”, J. Atmos. Ocean. Tech, in press.